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Research Article

Revelation and Management of Distal Anterior Cerebral Artery Aneurysms

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Abstract

Pericallosal aneurysms can affect any segment of the anterior cerebral artery distal to the anterior communicating artery. They represent relatively 9% of all intracranial aneurysms and are mainly revealed by a hemorrhagic stroke in different forms. This retrospective study reviewed all patients that received clipping for DACA aneurysms among all cases of brain aneurysms. 10 patients were included in this group and several parameters were evaluated. 60% of patients were female and their ages ranged from 44 to 78 years. 80% of candidates complained of headaches and 50% presented seizures clipping. 60% of patients presented an IPH at their first presentation while SAH was found in half of them. A good WFNS score was noticed and almost of patients (80 %) were graded I. Most of aneurysms (80%) were located at the pericallosal – callosomarginal junction. We had two cases (20%) with additional aneurysms in other localizations. All of them received microsurgical clipping. most of them had good short and long-term follow-ups. We had one death after several systemic complications. DACA aneurysms are revealed at a small size with the onset of cingular hematoma or SAH, especially in the interhemispheric cistern. This could affect the cognitive functions and is considered a determining factor in the patient's quality of life. The surgical clipping is an effective and durable option for their management.

***Keywords:** Cingular, Cognitive, Microsurgery.*

Introduction

The other nomination that has been awarded to pericallosal aneurysms was "distal anterior cerebral artery aneurysms (DACA)". this entity includes all aneurysms located distal to the anterior communicating artery [1]. The principal trunk of the anterior cerebral artery is located deep in the interhemispheric fissure, having a close relationship to highly eloquent structures such as the optic chiasm, third ventricle, and cingulate gyrus. Their incidence ranges between 1.5 to 9% of all intracranial aneurysms[2]. In some works, a previous history of cranial traumatism was reported to participate in the genesis of pericallosal aneurysms. Their formation was reported to be the result of important dynamism between the arteries, the brain, and the falx [3, 4].

Both endovascular[5] and microsurgical clipping [6] were adopted as therapeutic modalities for the exclusion of aneurysms in this location. The distal location of this malformation remains challenging for the endovascular therapy and this is due to difficulties in control of microcatheter in such tortuous and narrow vessels [7]. Their microsurgical pathway to the aneurysm is laborious thus requiring perfect knowledge of anatomy.

The revelation is made by headaches or hemorrhagic strokes in both forms; ventricular or parenchymal[9].

In this study, we report our experience in the management of patients harboring DACA in our department. Several parameters were analyzed during the review of their medical files. The immediate postoperative course and long-term fellow up were also evaluated.

Methods

Study design

This work is a retrospective study, that collected all patients operated for DACA in the Department of neurosurgery at Mohamed Lamine Debaghine University Hospial in Algiers.

Study population

Between January 2000 and August 2022, more than 300 patients with brain aneurysms were operated on in our department. Only patients operated for distal anterior cerebral artery aneurysm were included in the present work.

Data collection

We have obtained these data from the medical files of all patients and details of surgical parameters were collected from their individual operative reports. Several parameters of the revelation, management, and the postoperative period were evaluated. Detailed characteristics of the aneurysm, the hemorrhagic stroke, and the surgical technic were also reviewed. Usual grading scores of subarachnoid hemorrhages (WFNS and Fisher Scores) were applied to evaluate the severity of the stroke.

Results

We had 10 patients that presented and were operated on for DACA in the studied period. We had a female sex predominance in the studied group of patients, with 6 women. The age ranged from 44 to 78 years old. More than half of them were from the fifth decade of life with 6 patients (60%). We had more than 2 patients (20 %) from the fourth decade, one from the fifth, and the last one from the 7th decade of life. 4 candidates (40%) were without previous history of disease and 3 others (30 %) had hyper-blood pressure disease.

In the clinical presentation, we have considered mainly the presence of; headaches, seizures, cognitive disorders, and the increased intracranial pressure (IICP) syndrome. More details were specified about the form, the class, and the severity of the three first symptoms respectively. Headaches were present in 8 patients (80%); acute in 7 and chronic only in 1 patient and they were absent in 2 other cases. All acute forms of headaches were concomitant with a hemorrhagic event. 50 % of patients presented with seizures (simple generalized in 4 cases and complex generalized in 1 case). 8 patients (80 %) didn't present increased intracranial pressure syndrome and only 2 patients had this syndrome at their first presentation. Interestingly, no patient in our studied group complained of a motor deficit at their initial consultation. Cognitive disorders were present in 4 patients; severe in three and moderate in one. they were associated with other symptoms of the frontal syndrome as behavioral disorders affecting differently the quality of life. The other 6 patients didn't complain of these disabilities. We have used the WFNS scale to evaluate the preoperative status of patients, and we have noticed that almost all of them had a good clinical presentation with 8 patients in grade I, 1 patient graded II and the last one had a poor clinical status with a grade IV.

All patients had CT scans at their first presentation and three features were evaluated; the subarachnoid hemorrhage (SAH), intraparenchymal hematoma (IPH), and the intraventricular hemorrhage (IVH). Arachnoid hemorrhage was present in 5 patients (50 %) with different localizations, among this subgroup the basal cisterns were affected in 4 of them; alone in one case, associated with the anterior interhemispheric cistern (2 patients) and in the fourth case both Sylvian, anterior interhemispheric and basal cisterns were affected by bleeding. For the remaining patients, they didn't present SAH. 6 patients (60%) presented IPH. the cingulate gyrus was mainly affected in 5 of them and the sixth patient had an interhemispheric hematoma. The left side was the most concerned for 4 patients while the right side was in one case. The IVH was present in 3 patients (30%); third ventricular (1 patient) and tetra ventricular (2 patients). 70% of patients didn't present IVH at their first presentation. For radiological grading, Fisher score was applied. we have noticed 7 patients (70%) with grade 4, 2 patients with grade 2, and one case with grade 1. We have reviewed also the presence and the timing of the appearance of hydrocephalus.

At their initial consultation, only 2 patients (20%) had a moderate ventriculomegaly that didn't necessitate drainage. In one case, a patient (10%) presented hydrocephalus 18 days after microsurgical clipping of the aneurysm and had a ventriculoperitoneal shunt as management. the 7 (70%) other patients didn't present hydrocephalus.

For the etiological study, we have performed at least one of the following imaging modalities; Angio-CT, Angiography, and angio-MRI were used in 50 % of patients. The angio-CT was mostly used in 6 patients (60%). At the early stages of developing this cerebrovascular surgical activity in our department, the availability of these modalities was reduced, a thing which explains the previously mentioned percentages.

The number and the topography of aneurysms were evaluated in the available etiological studies. The aneurysm was unique affecting the DACA in 80 % (8 patients) and it was associated with a right posterior communicating artery aneurysm in 1 patient. another patient had two other aneurysms of the Sylvian bifurcation in addition to the pericallosal aneurysm. The pericallosal – callosomarginal junction was mostly affected in 80 % of cases (8 patients). Two patients (20%) had an aneurysm at the junction of the A2 and frontopolar artery. The size of the dome and the neck were measured in millimeters. the size of the dome ranged between 2 and 15 mm while the neck's size ranged between 2 and 6 mm. The aneurysms were small to medium-sized and without reporting the occurrence of a giant form in our group. We have studied also the aneurysm's projection and noticed that most of them had an anterosuperior projection (60% of cases). It was anterior in 3 patients (30 %) and anteroinferior in 1 patient (10%).

All patients (100%) had a microsurgical clipping of the aneurysm using a targeted craniotomy. the surgical approach was selected after an appropriate analysis of the imaging especially the topography and the projection of the aneurysms. The interhemispheric arachnoidal microsurgical progression was applied in all patients to gain the DACA, its branches, and the aneurysms after the selected approach. The most applied approach was the right frontal parasagittal, followed by an interhemispheric progression. This technique was performed on 6 patients (60%) the bifrontal craniotomy was used in 1 patient (10%) and the left frontal parasagittal one was used in 1 patient (10%). For double and multiple aneurysms that were found in 2 patients (20%), we have performed a large approach combining a pterional to a frontal parasagittal bone flap. We aimed to gain access simultaneously to basal and interhemispheric cisterns. In 9 patients (90 %), we have excluded the DACA aneurysm using one clip in the last case (1 patient), we have used 4 clips to exclude the aneurysm. We reviewed in this work the timing of surgical management after the initial diagnosis; bleeding event in 9 patients (90 %) and radiological investigation in 1 patient (10%). It ranged from 1 week to 1 year. 6 patients (60%) were operated on within one month after the revelation. and 2 patients were operated on 2 to 3 months after bleeding. in 1 case, the patient was diagnosed elsewhere with a brain hematoma and then referred to our department lately where the etiological investigation revealed a DACA aneurysm. Such delayed management is because many patients are referred to us from other departments in all the provinces of the country where specialized physicians and radiological investigations are unavailable. We have inserted external ventricular drainage (EVD) only in 1 patient (10%) to manage an infectious episode of meningitis that happened 11 months after surgery. Ventriculoperitoneal shunt (VPS) was also performed in the only and same patient (10 %) because he presented a delayed and symptomatic hydrocephalus 18 days after microsurgical clipping.

An uneventful postoperative period is defined by the immediate extubation of the patient in the operating room and the absence of complication as seizures, motor deficit, or consciousness disorders the first night in the intensive care unit. This period extends from day 1 after surgery to the day of discharging the patient at 8 to 10 days. When complications existed, they are mentioned with their date of appearance. In 8 patients (80%), the postoperative period was uneventful. We have noticed usual and conservatively managed complications in this subgroup of patients as CSF leak (1 patient), hemiparesis (1 patient), and cognitive disorders that existed already before surgery. 1 patient (10%) was kept intubated after the end of surgery then he was extubated on day 4. He remained stable and he was discharged 12 days after surgery. In the last patient (10 %), the immediate postoperative evolution was good and the patient was discharged 10 days after surgery, he presented some worsening of his previous cognitive dysfunction and CT scan showed a tetra-ventricular hydrocephalus for which a VP shunt was implanted. The patient presented two episodes of meningitis and shunt dysfunction for which the VP shunt was removed and an EVD was performed. The last event was at 11 months after surgery when he presented systemic septicemia and an important cerebral hematoma that was removed but the patient presented a cardiorespiratory arrest a few hours after the end of surgery. Finally, we reviewed the status of patients during long-term follow-up and this was performed at the office 18 to 48 months after surgery. Both clinical and radiological parameters were reviewed. We had one case (10%) of a patient with severe cognitive disorders that unfortunately didn't improve, he maintained a poor quality of life, requiring almost total assistance from his family. Another patient (10%) presented a motor deficit after surgery that was related probably to a venous infarct that resulted after the sacrifice of some parasagittal veins.

The patient received physical rehabilitation and a clear improvement of the paresis was noticed. For the rest of the patients (70%), clinical status was excellent with a good quality of life and without motor or cognitive deficits.

Table 1: Results of studied parameters.

Case	Age/Sex	History	Headaches	Seizures	IICP	Motor deficit	Cognitive disorders	WFNS Grade
1	57/ M	/	P/Acute	P/1 Generalized episod	P	A	P/ Severe	IV
2	56/F	Diabetes / HBP for 6 years	P/ Acute	A	P	A	A	I
3	57/F	HBP	P/Acute	A	A	A	A	I
4	52/F	Allergy	P/Acute	P/1 Generalized episod	A	A	A	I
5	44/M	cerebral palsy	P/Acute	A	A	A	P/ Severe	I
6	65/F	HBP	P/chronic	A	A	A	A	I
7	51/F	Uterine myoma	P/Acute	A	A	A	A	I
8	48/F	/	P/Acute	P/1 Generalized episod	A	A	P/ moderate	II
9	78/M	/	A	P/1 Generalized episod	A	A	A	I
10	51/M	/	A	P/1 Generalized complex	A	A	P/Severe	I

Table 2: Results of studied parameters.

Case	CT scan	SAH	IPH	IVH/Localization	Fisher score	Hydrocephalus
1	perf	A	P/ left anterior cingular gurys	P/ Tetraventricular	4	A at initial presentation than P 18 days after cliping
2	perf	P/ Anterior IH and basal cisterns	P/ left frontal including cingulate gyrus	A	4	A
3	perf	P/ basal cisterns	A	P/ Third ventricle	4	P/ moderate hydrocephalus
4	perf	P/IH cistern	A	A	2	A
5	perf	P/IH + basal cistern	P/ interhesmispheric	A	4	P/ moderate hydrocephalus
6	perf	A	A	A	1	A
7	perf	P/ IH + basal cistern+ both sylvian fissures	A	A	2	A
8	perf	A	P/left frontal (anterior cingluate gyrus)	P/Tetraventricular	4	A
9	perf	A	P/left frontal (anterior cingluate gyrus)	A	4	A
10	perf	A	P/right frontal / (anterior cingulate gyrus)	A	4	A

Table 3: Results of studied parameters.

Case	Angiography	Angio-MRI	Aneurym(s) / Topography	Dome (mm)	neck (mm)	Projection
1	Perf	Perf	unique /right pericallosal-calosomarginal junction	15mm	4mm	Anterior to the left
2	Perf	Not perf	unique /left A2-frontopolar junction	8mm	4mm	Antero-inferior to the left
3	not perf	Not perf	double / right Pcom + right pericalosal-calosomarginal junction	Pcom: 12mm pericallosal : 4mm	Pcom: 3mm/ pericallosal : 4mm	Pcom: medial/ pericallosal : Antero-superior
4	Perf	Perf	unique/ left paricalosal-calosomarginal junction	12mm	6mm	Antero-superior to the left
5	not perf	Perf	unique/ left paricalosal-calosomarginal junction	5mm	4mm	Antero-superior
6	not perf	Not perf	multiple/Two at right sylvian bifurcation + right pericalosal-calosomarginal junction	sylvian : 7mm, 5mm/ pericallosal : 2mm	sylvian: 3mm,4mm/ pericallosal: 3mm	Antero-superior
7	not perf	Perf	unique/ left paricalosal-calosomarginal junction	6mm	3mm	Anterior
8	Perf	Not perf	unique/ left paricalosal-calosomarginal junction	10mm	3mm	Antero-superior to the left
9	not perf	Not perf	unique/ left A2-frontopolar junction	7mm	4mm	Antero-superior to the left
10	Perf	Perf	unique/left pericallosal-calosomarginal junction	11mm	2mm	Anterior to the right

Table 4: Results of studied parameters.

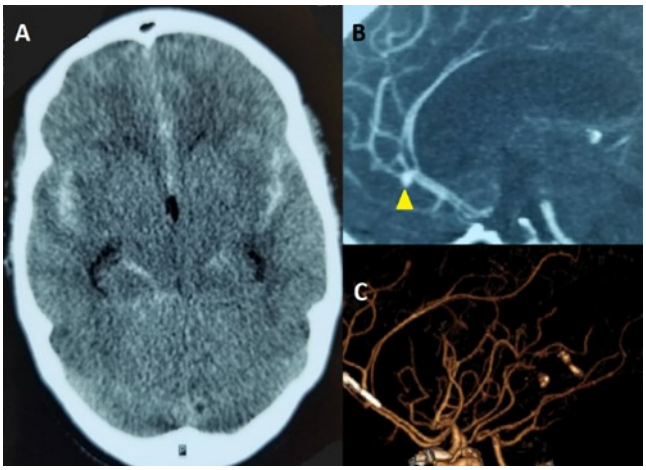
Case	Approach	Technic	Timing of surgery after bleeding	EVD	VP shunt	Early postoperative period	Long term follow up
1	Interhesmispheric / right F parasagittal	cliping (unique)	20 days	during an episod of meinigitis (11 months post op)	Perf/ 18 days after cliping	stable (cognitive status)/	hydrocephalus (18 days postop) / meningitis (2 episodes) / extensive cerebral venous infarct (11 months postop)/ death
2	interhesmispheric / bifrontal craniotomy	cliping / two clips	3 months	not perf	not perf	kept sedated initially than extubated 4 days after and remained stable	good

3	combined right pterional-F par-asagittal	cliping / two clips	1 month	not perf	not perf	uneventful	good
4	interhemispheric / right F parasagittal	cliping (unique)	7 days	not perf	not perf	uneventful	good
5	interhemispheric / right F parasagittal	cliping (4clips)	22 jours	not perf	not perf	uneventful/ CSF collection	good
6	combined right pterional- F parasagittal	cliping (unique)	no bleeeding event	not perf	not perf	uneventful/ left hemiparesis	good (improvement after rehabilitation)
7	interhemispheric / left F parasagittal	cliping (unique)	15days	not perf	not perf	uneventful	good
8	interhemispheric / right F parasagittal	cliping (unique)	2 months	not perf	not perf	uneventful	good
9	interhemispheric / right F parasagittal	cliping (unique)	1 month	not perf	not perf	uneventful	good
10	interhemispheric / right F parasagittal	cliping (unique)	1 year	not perf	not perf	uneventful / cognitive dis-orders re-mained stable	Residual cognitive disorders

Abbreviations:

M: male, F: female HBP: hyperblood pressure, P: present,Pcom : posterior communicating A: absent, IICP : increased intracranial pressure ,Perf : performed , SAH: subarachnoid hemorrhage, IH: interhemispheric, IPH: intraparenchymal hematoma, IVH : intraventricular hemorrhage , F : frontal , EVD :external ventricular drainage , VP: ventriculoperitoneal .

Illustrative cases



Case 1- Figure 1*: A 51 year old female with previous history of uterine myoma that presented 1 month before her admission severe headaches and photophobia. The brain CT showed a diffuse SAH (Fisher 2) and was graded WFNS I. The angio CT showed a left DACA aneurysm located at the left pericallosal-calosomarginal and was relatively small (neck :3mm/ dome :6mm). the patient had a microsurgical clipping through a left frontal parasagittal craniotomy. the exclusion was achieved using a single clip. The postoperative course was uneventful and the angio CT showed a complete exclusion with a good patency of the other vessels.*

Case2-Figure2:

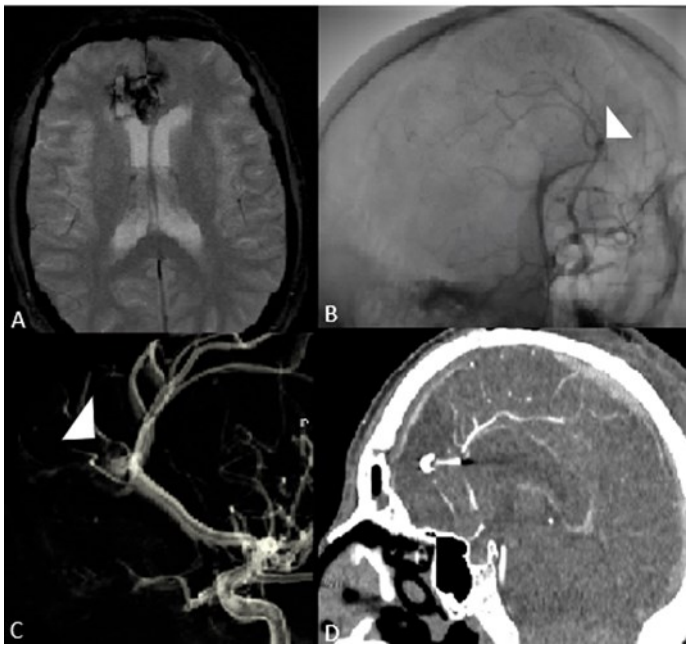


Figure 2: *A male aged of 51 years presented an acute phase of generalized complex seizures. MRI (gradient-echo T2) showed an anterior cingular hematoma in the right side (image A). The angiography showed a left pericallosal-calosmraginal junction aneurysm (neck: 2mm /dome: 11mm) (arrowhead in the images B and C). the access to the neck was made after two episodes of temporary clipping of the parent vessel and the definitive exclusion was achieved using a single clip. the postoperative Angio-CT demonstrated a complete clipping of the aneurysm (image D).*

Discussion

DACA aneurysms, known also as pericallosal aneurysm could be found at any segment of anterior cerebral artery from A2 to A5 or at their most distal branches. They represent a subgroup of 6% of all brain aneurysms [1]. Women were mostly affected by this form of vascular malformation as it was reported in previous studies [2, 10]. We have noticed two patients (20 %) with more than one aneurysm (two in one case and three in another case). All of these aneurysms were located on the right side of the Willis cycle. We didn't notice an aneurysm in a mirror position among our patients. One author reported that bilateral and symmetrical topography of DACA aneurysms was present in 21% of his patients [11].

The revelation was made in 9 patients (90%) by the onset of an acute form of a brain hemorrhage. The distribution of analyzed clinical symptoms was; that headaches were acute in 7 patients (70%) and chronic in one patient (10%). Seizures were generalized in all the 5 patients (50%) and interestingly they were associated with parenchymal hematoma. We have noticed only 2 patients (20%) that presented an increased intracranial pressure syndrome. No motor deficit was noticed in all of the cases and this was due to the topography of the hematoma in the cingulate gyrus. 4 patients (40%) had cognitive disorders at their first clinical evaluation. Among this subgroup, these neurological disorders were severe in 3 and moderate in 1 patient. Such symptoms were related to anatomical and functional damage to vascular territories of the distal anterior cerebral artery as the cingulate gyrus, the supplementary motor area, and some components of the limbic system[12, 13]. Most of the patient had a good clinical status at their first presentation with 8 patients (80%) graded I according to the WFNS scale. 1 patient had a grade II and another one had a poor clinical status and was graded IV. In one work[14], 68.4% of patients had a good initial clinical presentation. the importance of the hemorrhagic stroke and its form are the main determinative factor in the first clinical status of the patient during the revelation of these aneurysms. The initial CT revealed mostly the presence of an intraparenchymal hematoma in 60% of patients associated differently with other forms of bleeding as subarachnoid and intraventricular hemorrhage. The most anatomical affected structure was the cingulate gyrus because of its location to the ruptured aneurysm and this was noticed in 5 patients. In the sixth case, the hematoma was located within the anterior interhemispheric space.

At the etiological evaluation, the DACA aneurysm was located at the pericallosal-calosomarginal junction in 80% of patients. in the remaining 2 patients (20%), the A2-frontopolar junction was the affected vascular part by the aneurysm. 1 patient had an additional Pcom aneurysm and another one with two other sylvian bifurcation aneurysms. These results look similar to some other findings in another work[6], where 85 % of aneurysms were located at the pericallosal-calosomarginal junction and affected the A2-frontopolar bifurcation in 15 %. Some authors had a percentage of 100 % of the aneurysms at the pericallosal-calosomarginal bifurcation [15] . Their size was relatively small; with a dome ranging from 2 to 15mm and a neck ranging between 2 to 6 mm. 86 % of a ruptured aneurysms in another report, had a diameter lesser than 7 mm [16]. The timing of surgery in these patients ranged from 7 days to one year after the hemorrhagic event. such a difference in the treatment time was mainly conditioned by the clinical condition, the attendance of the patients, and the availability of specialized consultation. All patients had a microsurgical clipping of their malformations through the interhemispheric route. a right frontal parasagittal bone flap was applied in 90 % of cases, and among them the bony exposure was combined to a pterional approach to gain access to sylvian and Pcom aneurysms in 2 patients. A bifrontal craniotomy was used in 1 patient (10 %).

As it was reported in previous work [17], great care is made to preserve all parasagittal veins during dural opening and only veins that could stop a capital dissection to the interhemispheric fissure are sacrificed when they are small. During interhemispheric progression, the dissection was maintained in the arachnoidal plan between the frontal lobes with preservation of the olfactory tracts and aimed to expose the parent vessel and the aneurysmal neck. The deep location of the fissure and the disruption of the arachnoid and pia especially after the onset of a SAH or cingulate hematoma make this surgical step challenging [15, 18]. Microsurgical exclusion is an effective option with acceptable rates of occlusion and bleeding risk of 0.4 % during 10 years of follow-up [19]. In 90% of patients, the aneurysmal occlusion was achieved using a single clip across the neck with preservation of the blood flow in the parent vessel and only 1 patient (10%) required 4 clips to exclude the malformation with the occurrence of an intraoperative rupture that was well controlled. The insertion of a VP shunt was performed in one patient (10%) that presented first a tetra ventricular dilation 18 days after surgery that could be related mostly to the first hemorrhagic event and the initial surgery. The same patient had an unfavorable evolution and presented two episodes of meningitis that were treated and where the shunt was removed and EVD was placed.

Two periods of the postoperative course were evaluated, the first was the early period; from the first day after surgery till the day of leaving the hospital. We had 50% of the patient that had an uneventful period after surgery and were discharged 1 week after 1 patient had a CSF collection that was managed conservatively. 1 patient had a good recovery after surgery but presented a hemiparesis. In 2 cases that had already before surgery severe cognitive disorders, they remained stable after the aneurysmal exclusion. 1 patient was extubated 4 days after surgery and had the rest of the evolution good. During follow-up, all patients received an Angio CT between the third and the sixth month. The late period in this work was defined as the phase that starts 2 years after surgery. 80% of patients had a good clinical status without any neurological deficit. We had one case that didn't improve his disabling cognitive disorders. We noticed a poor evolution in 1 patient that presented several episodes of meningitis after being shunted. unfortunately, he had a severe consciousness and died a few days after being admitted to the intensive care unit. This was related to a venous infarct and septicemia. Similar results were reported in one work, where 73% of patients had a favorable outcome, 20% with a bad evolution, and one case of death [16].

The endovascular option remains also an effective option for managing aneurysms in this location. In 1996, one team described the first coiling of DACA aneurysms in a group of 8 patients [20]. The technical difficulties that were reported were related to the distal position of the malformation which led to weak control of the used microcatheter [21]. In addition to that, another author reported that aneurysms of this location were associated with the onset of rupture during the surgical procedure [22].

Limitations

The heterogeneity of the radiological exploration for some patients is one of the limiting factors for a better impact of the present work. The work includes only 10 patients, which is not a large series that could be followed as a significant reference. Retrospective aspect of the work is the one other limiting fact.

Conclusion

The microsurgical clipping of DACA aneurysms is an effective option for management without significant mortality. They are marked by their relatively small size and difficulties of exposure related to their deep location in the midline and previous adhesions of the arachnoid after bleeding. The most disabling neurological deficit was the cognitive disorders related to lesions of the cingulate gyrus and other important anatomical structures around the aneurysm.

The anterior interhemispheric approach offers an adequate surgical corridor to control the parent vessel for temporary clipping and the aneurysmal neck for definitive exclusion.

What already known on this topic:

- DACA aneurysms could be found at any segment of anterior cerebral artery from A2 to A5 or at their most distal branches.
- They represent a subgroup of 6% of all brain aneurysms.
- They are mainly revealed by a hemorrhagic stroke in different forms.

What this study adds

- The experience of nearly 20 years of a single institution in the diagnosis and the management of Distal Anterior Cerebral Artery Aneurysms.
- The work is about 10 patients harboring Distal Anterior Cerebral Artery Aneurysms that were diagnosed and operated. How this study might affect research, practice or policy.

Conflicts of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Authors' contributions

All authors contributed equally to the manuscript and read and approved the final version of the manuscript.

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